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1 Acknowledgements

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1.1 Acronyms

CLUA:	Clan Land Use Agreement
DWU:	Divine Word University
EHP:	Eastern Highlands Province
FA Goroka:	PNG Forest Authority, Highlands Area Office, Goroka
FPCD:	Foundation for People and Community Development
FRI:	PNG Forest Authority, Forest Research Institute, Lae
FRO:	Forest Resource Owner
ILG :	Incorporated Land Group
M&E:	Monitoring and Evaluation
MOU:	Memorandum of Understanding
MTDP:	PNG Medium Term Development Plan
NGO:	Non-Government Organisation
PIP:	Pacific Island Projects
PNG:	Papua New Guinea
PNGFA:	PNG Forest Authority
RAIL:	Ramu Agri Industries Ltd

RMV:	Ramu/Markham Valley
SABL:	Special Agricultural and Business Lease
SRA:	Short Research and Development Activity
TA:	Timber Authority
UPNG:	University of Papua New Guinea
USC:	University of the Sunshine Coast

2 Executive summary

Australian Centre for International Agricultural Research (ACIAR) project 'Enhancing the implementation of community forestry approaches in Papua New Guinea' ran between 2013-2017. The University of the Sunshine Coast (USC, via the Tropical Forests and People Research Centre) was the commissioned organisation. The project was implemented in collaboration with (1) the Papua New Guinea Forest Authority (PNGFA); 2) the Papua New Guinea Forest Authority, Forest Research Institute (FRI); 3) Ramu Agri Industries Ltd (RAIL); 4) the Foundation for People and Community Development (FPCD); and (5) the University of Papua New Guinea (UPNG).

The purpose of the project was to identify how community forestry in Papua New Guinea (PNG) could be enhanced and scaled-up to achieve better economic, social and environmental outcomes. The research focused on three main objectives (1) enhancing the scaling-up of community management of native forests; (2) developing appropriate systems for the scaling-up of community-based reforestation of grasslands; and (3) analysing policy and institutional systems that can support enhanced implementation of community forestry in the PNG.

For Objective 1, a financial analysis of clan-based selective harvesting of native forest using portable sawmills, found that long-term profitability was unlikely. Research into intra- or inter-clan cooperation found that economic activities generally occur at a household or extended family level, not at the level of clans. Hence, further research is needed to develop improved processes and institutional arrangements for communities to access formal value-added timber markets. Institutional change to legalise and manage current quasi-legal harvesting by private sawmills will require active government support.

To address Objective 2, multi-species and variable spacing field trials were established at Ramu and at Goroka. Research into community dynamics suggested that collective action for tree planting (as single or multiple clans) is unlikely. Women's participation is reduced by their traditional exclusion from clan governance. Further research is needed to understand how community dynamics and gender issues may best be addressed during reforestation projects.

Although a lack of seed or seedlings is an inhibition to the adoption of tree growing in remote parts of the highlands at Goroka, widespread planting of *E. pellita* between Lae and Ramu has resulted in seed for this species being widely available. The high cost of road transport effectively precludes transport of small volumes of sawlogs from Ramu to processors in Lae. Training which had supported the establishment of charcoal producer groups in project *FST/2011/058* was found to have had no long-term effect because of high transport costs and a lack of a permanent market venue in Lae.

Research into Objective 3 focused on a review of policies and legislation relevant to community forestry in native forest in PNG, particularly the impact of forest policy on decision-making by landowners. The research confirmed that existing policies and regulations, including financial and transaction costs are major barriers to sustainable harvesting. A further key finding was that, there is a need for explicit policies which simplify restrictive regulations and which enable clans to participate effectively in timber markets.

A key impact of the project is the need to redirect institutional arrangements and material support for reforestation to families and family groups rather than the current clan-based approach. Encouraging families to engage in multi-species (fruit and nut) tree planting as an adjunct to cash-crops may be more successful than broad-scale plantings which are vulnerable to wildfires and for which there are few current market opportunities.

3 Background

The key issues which the project sought to address were the current unsustainable management of PNG's community-owned native forests and the reforestation of the country's community-owned grasslands. The background to these issues is that forests in PNG cover nearly 29 million hectares or sixty-three percent of the country, and ninety-seven percent of these forests are held in customary land ownership. Most of the forests are tropical, and contain over 400 tree species that are utilised for commercial or domestic applications. There are also currently around 86,000 hectares of plantations of mostly exotic tree species throughout PNG's highlands and lowlands, but many of these plantations are of a poor quality. About eighty percent of the country's population live in rural areas and they depend heavily on community-owned forests for fuelwood, housing timbers and a variety of non-wood forest products.

The PNGFA is entrusted with the sustainable management of the nation's forest resources. The aim of the PNGFA is to achieve economic growth and employment creation, with greater Papua New Guinean participation in the forestry industry and increased on-shore processing of harvested timbers. Customary land ownership is recognised by the PNG Constitution and the forest which grows on customary land is owned by the clans. In order to carry out any forest-related operations on customary land (such as the harvesting of timber or other forest products, or reforestation), extensive consultation must occur between State Agencies, including the PNGFA, and the landowners. Any harvesting operation by outsiders on customary land requires the agreement of the customary landowners.

The PNGFA has developed a draft *National Eco-Forestry White Paper* (2004) and a *Reforestation Policy* (i.e. the National Forest Plan - see NFP, 1991) in support of their sustainable forest management mandate. These are indicative policies of the emerging focus on forest practices other than industrial-scale logging. However, these policies have yet to be formally adopted.

The importance of forestry to the economy of PNG is reflected in the PNG Medium Term Development Plan (MTDP) for 2016-2017 (MTDP, 2015), which recognises that the forest sector is very important for PNG for the following reasons:

- 'People in rural areas largely depend on the forest. The forest provides wood for housing, fuel for cooking, fodder, forest-based medicines, food and meat as well as forest products for internal consumption and exports;
- Forest-based industries such as sawmills depend on forest products' (pp.66-67).

The MTDP recognises that in recent years the forest has been greatly degraded and depleted due to excessive logging and this trend needs to be stopped (MTDP, 2015). Bond (2006) indicated that policy implementation is severely constrained by capacity and resource limitations of PNG's government agencies. Filer and Sekhran (1998) also noted that community-based non-government organisations (NGOs) have played, and are likely to continue to play, important roles in forest policy implementation.

Forest management in PNG is in transition, from export-oriented harvesting of logs from primary forest to an increased focus on sustainable management of secondary forest, regrowth forests and plantations, the domestic processing of forest products, and a growing recognition of the importance of other forest values such as carbon and biodiversity. There is also a growing recognition of the importance of small-scale forestry operations to process logs harvested from natural forests. In addition to unlogged natural forest, there exists large areas of community-owned secondary native forest (recovering from previous logging) and there is widespread use of agroforestry systems by landowners in rural areas to which

community management of native forests, (locally termed 'ecoforestry'[1]) could also be applied. Several NGOs have also worked with local communities to implement small-scale harvesting and processing with mobile sawmills, but evidence of their profitability is scant.

In addition, there are large areas of community-owned grassland throughout PNG and clans are looking for opportunities to use this land productively. Community-based reforestation of grasslands has great potential to produce economic returns to clans, while also producing positive social and environmental outcomes.

During consultations undertaken in 2012 as part of an ACIAR funded 'Small Research and Development Activity' (SRA, *FST/2010/044 Opportunities for Community-Based Forestry in Papua New Guinea*) which included various PNG stakeholders, the importance of achieving effective engagement, participation and empowerment of communities and landowners (i.e. the resource owners) in the sustainable management of PNG's forests was identified as an essential element for achieving sustainable forest management. These discussions revealed that community forestry is developing in two main ways which are directly related to the nature and characteristics of the forest or land resources to which communities have access, namely:

- 'Ecoforestry' on community-owned native forest;
- Reforestation of community-owned grasslands.

The SRA team identified the native forests surrounding Madang as appropriate for research into ecoforestry and the grasslands of Ramu and Goroka as appropriate for research into reforestation. Consequently, the ACIAR forestry strategy for PNG included the following research priority:

Research into models for enhancing and scaling-up community engagement in tree growing and sustainable forest management

The SRA and a review of the literature relating to the factors affecting the success of community forestry, followed by a two-day workshop with key stakeholders, identified three priority research areas. These are reflected in the aim and objectives of this project.

The key research questions were:
(1) How to enhance community-based ecoforestry in native forests;
(2) How to develop appropriate systems for the scaling-up of community-based reforestation in grasslands; and
(3) How policy and institutional systems can support enhanced implementation of community forestry in PNG.

These research questions provided three focal points or objectives for the current project. First, research focused on understanding the opportunities and challenges for communities to become involved in ecoforestry and reforestation, including an assessment of the value-adding opportunities available to communities. Because clans are central to the customary land ownership system in PNG, a second focus of the project was to understand community dynamics, decision-making processes and institutional arrangements in relation to community forestry. The policy environment is also a critical element in scaling-up community forestry in PNG. Hence, a third focus was to assess the impact that policy has on landowner decision-making.

In the Eastern Highlands Province (EHP), the RMV and at Madang, project staff used the information obtained in the SRA, the literature, the workshop and other consultations as the background to research which provided answers to the research questions. It is expected that this project will be the first phase of a 10-year research program into the scaling-up of community forestry in PNG.

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[1] Ecoforestry in PNG usually refers to communities harvesting timber from primary and secondary forest on their clan lands and processing it using a small-scale sawmill. The term is used in this context.

4 Objectives

The aim of this project was to identify how community forestry in PNG can be enhanced and scaled-up to achieve better economic, social and environmental outcomes.

The three main research objectives and related activities were:

Objective 1. Enhance the scaling-up of community ecoforestry in native forests

Activity 1.1 Analyse value-adding opportunities;
Activity 1.2 Understand community dynamics in relation to ecoforestry;
Activity 1.3 Identify key drivers likely to affect scaling-up success;
Activity 1.4 Implement scaling-up activities;
Activity 1.5 Monitoring and evaluation.

Objective 2. Develop appropriate systems for the scaling-up of community-based reforestation of grasslands

Activity 2.1 Establish field trials to fill critical gaps in technical knowledge;
Activity 2.2 Assess potential markets;
Activity 2.3 Understand community dynamics in relation to reforestation;
Activity 2.4 Identify key drivers likely to affect scaling-up success;
Activity 2.5 Identify ways to improve access to germplasm;
Activity 2.6 Implement a 'train-the-trainer' program;
Activity 2.7 Design and test improved community forestry systems;
Activity 2.8 Monitoring and evaluation.

Objective 3. Analyse policy and institutional systems that can support enhanced implementation of community forestry in PNG

Activity 3.1 Assessment of policy impacts on decision-making by landowners;
Activity 3.2 Policy workshop to review ecoforestry/community forestry policy;
Activity 3.3 Recommendations for institutional arrangements to support community forestry.

The envisaged outputs for each research objective were:

- Objective 1: Analysis of value-adding opportunities for community-based ecoforestry including a business case for the most promising harvesting opportunities; and identification of the critical community dynamics, decision-making processes and local institutional arrangements required to implement ecoforestry.
- Objective 2: Field trials; training workshops and extension materials; identification of reforestation systems suited to community needs; identification of the critical community dynamics, decision-making processes and local institutional arrangements required to implement community forestry; and recommendations for scaling-up initiatives.
- Objective 3: Reports outlining the implications of policy on the decision-making processes of landholders, and opportunities for institution and policy development.

5 Methodology

The conceptual background to project research was guided by the nature of PNG clan-based society, as reported in Appendix 1, and a theoretical model of the factors which influence the success of community forestry world-wide (Appendix 2). The project necessarily involved a multi- and inter-disciplinary research approach, and strong partnerships between researchers and field-based staff, and between different project partners. The research approaches and partnerships relating to each project objective are outlined in the following sub-sections. As the lead agency for forestry in PNG, the PNGFA became the lead partner for the project.

Project Sites

The project operated in the Madang-Lae-Goroka triangle, as recommended by the SRA team. More specifically, the project activities were conducted in:
(1) Native forests adjacent to Madang[2];
(2) Communities living in the RMV[3]; and
(3) The Eastern Highlands, adjacent to the towns of Goroka and Kainantu (Figure 1).

Madang is surrounded by native forest. For this reason it was selected as a suitable location for research into ecoforestry in PNG. The FPCD has facilitated community involvement in ecoforestry in the Madang area for several years. Hence, the FPCD was engaged to assist the project team to interact with communities in the Madang area to achieve Objective 1.

The RMV was chosen as a project site because it contains extensive grasslands which are considered well-suited to community-based reforestation. The RMV also extends southeast to Lae, the headquarters of the FRI. As part of the PNGFA, the FRI is the major forest research agency in PNG. RAIL is a large private company located in the township of Ramu. RAIL has a demonstrated internationally-recognised track record in reforestation and community development. Hence, both the FRI and RAIL were invaluable partners in achieving Objective 2. The towns of Goroka and Kainantu were also chosen for species trials and extension activities because the PNGFA has a regional office in Goroka and there are extensive tracts of grassland surrounding these two towns.

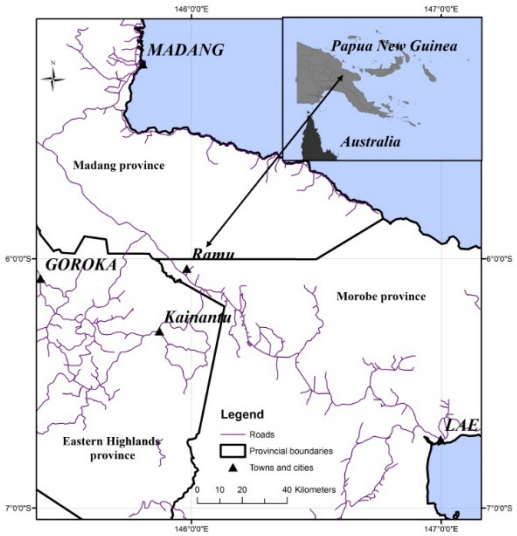

Figure 1. Map of Papua New Guinea showing the cities of Lae, Madang and Goroka and the towns of Kainantu and Ramu, adjacent to which the project activities were carried out.

[2] For convenience, in this report "Madang" refers to the area around Madang Town, not to Madang Province.

[3] RMV refers to the area around the town of Ramu. In fact, the Ramu Valley is also part of Madang Province, while the Markham Valley is in Morobe Province.

5.1 Methods specific to each project objective

5.1.1 Objective 1. Enhance the scaling-up of community ecoforestry in native forests

The main component of the work for Objective 1 was undertaken by Dr Robert Fisher (anthropologist, leading the Madang work), Dr David Smorfitt (focusing on market analysis and financial analysis) and Mr Mark Winai (a field officer with the FPCD). During 2014, Mr Peter Anga was also employed through the FPCD as a social science field researcher. In May 2016, USC PhD candidate Mr Micah Scudder also became involved in harvesting and marketing research. This research included visits to communities in Lae and Madang, an investigation of the profitability of NGO-supported portable sawmills and the operation of a small lumber yard in Lae.

Case studies were undertaken with three community groups which had previously been associated with the FPCD. The case study sites were selected on the basis that each site was accessible to Madang and all communities were interested in continuing their ecoforestry activities. The three case study communities were:

- Awane clan: Located at Erima Village;
- Dawen clan: Located at Aronis Village;
- Abul hamlet: Usually referred to as Sogeram, which is the name of the area.

Research centred around fact-finding visits to the three villages. Data collection included participant observation, formal interviews and informal discussions with individuals or groups and a review of documentation. During the interviews and discussions, questions were not posed as elements of a structured questionnaire or checklist, but were based on a guide of thematic concerns to be addressed by the researchers over the duration of field research. The themes included:

1. Community structure, and clan leadership power relationships;
2. Agricultural practices, livelihoods and outside employment;
3. Relationship between kinship/clan structure and forest tenure;
4. History of local level forest management within the community;
5. Interventions by outside agencies including government and NGOs;
6. Decisions about forest use and management by the community;
7. Which individuals or groups of individuals within the community make decisions;
8. Objectives of various stakeholders in the community for forest use and management;
9. Economic, financial and policy constraints or enabling factors assisting or hindering the achievement of these objectives;
10. Opportunities for cross-clan cooperation to address issues such as economies of scale; and
11. Information gaps (such as knowledge of markets and market change) to be addressed to support more informed community decision-making.

Activity 1.1 Analyse value-adding opportunities

The analysis of value-adding opportunities focused on social science research in the natural forests around Madang. The research involved multiple village visits by FPCD and Australian researchers. Information was gathered on factors which affect native forest harvesting and marketing, including log and sawn timber prices and options for alternative timber processing arrangements, such as the sharing of equipment between clans and out-sourcing timber processing. An assessment of the profitability of community-managed NGO-supported portable sawmills and the return to landowners from quasi-legal externally-owned portable sawmills was also undertaken (Appendices 3, 4, 5 and 6).

Activity 1.2 Understand community dynamics in relation to ecoforestry

A Social Science Training Workshop was undertaken at the start of the project to improve deficiencies in the research capacity of key partners. The workshop focused on qualitative research methods, particularly interviews.

As a contribution to obtaining an understanding of factors affecting decision-making about forests and understanding the value of forests both in social and livelihood terms, a "forest values and usage assessment" was undertaken in late 2015 (Appendix 7). This activity applied rapid appraisal tools adapted from the IUCN/PROFOR Forests-Poverty Toolkit (PROFOR-IUCN, 2015). A village-level case study was carried out near Madang. In the case study, workshops lasting several hours each were held separately with village men and women to identify the products and services they obtain from forests. Similar workshops were also held with two communities in the RMV.

Activity 1.3 Identify key drivers likely to affect scaling-up success

A series of interviews and discussions were held to explore potential scaling-up activities (Appendix 8). Project researchers interviewed community leaders in Madang, a timber purchaser/processor in Lae, and lumber retailers in both Madang and Lae. The interviews explored the barriers to the expansion of legal harvesting and processing. Lumber retailers were asked to describe their business model in terms of price competition, lumber standards and resource availability. Community leaders were asked about their knowledge of government requirements and process for legal harvesting, royalty rates and the possibilities for clan-wide cooperative action.

Activity 1.4 Implement scaling-up initiatives

This activity was not undertaken for two reasons. First, at the project design stage, the FPCD had indicated that they were working in three communities and were about to establish a log yard at Lae. ACIAR researchers had envisaged working closely with the FPCD. Unfortunately, when the project commenced, they found that FPCD activities had virtually ceased. This meant that some of the planned work under this activity was not possible. Researchers were unable to identify an alternative research partner. In addition, research undertaken as part of Activities 1.1. and 1.2 found that the complexity of community power relationships, land tenure, legislation and the prevalence of illegal harvesting is such that implementing ecoforestry, let alone scaling-up, was beyond the resources available to the project in the absence of an industry partner.

Activity 1.5 Monitoring and evaluation

Similar to Activity 1.4, this activity did not proceed. Monitoring and evaluation of scaled-up ecoforestry were largely negated by the unwillingness or inability of the three communities being assisted by the FPCD to engage in ecoforestry because of the scaling-back of FPCD activities.

5.2.2 Objective 2. Develop appropriate systems for the scaling-up of community-based reforestation of grasslands

Activity 2.1 Establish field trials to fill critical gaps in technical knowledge

A variable spacing trial and a mixed-species trial were established in Goroka (see Appendices 9 and 10) on land owned by the Department of Primary Industries, at a location 10 km southeast of Goroka. The trials were established as two square blocks of trees, each measuring 60m x 60m. Seedlings were planted in May 2016.

In the RMV, a major variable spacing and mixed-species trial of 3.3 ha was established at 'Jacob's Creek in June 2015. This trial has been planted with 20 native tree species in 50 plots of 20 individuals. Planting density was 1667 trees per hectare at a spacing of 2m x 3m. The trial was established on gleyed clay, this soil type being common in the RMV. Because gleyed clay soils are not preferred either by RAIL (for oil palm or sugar), a plantation forest company 'PNG Biomass' (for planting *E. pellita),* or by villagers for

vegetable gardens, they are potentially available for establishing woodlots of tree species which can withstand periodic inundation.

Activity 2.2 Assess potential markets

Project researchers investigated market opportunities for forest products at Ramu. They conducted interviews with potential purchasers – principally RAIL and PNG Biomass – concerning the market for small volumes of low- and high-value timber from geographically scattered locations.

Activity 2.3 Understand community dynamics in relation to reforestation

Community dynamics and decision-making were investigated using interviews, records of conversations and visual observations of what communities actually did. Data collection occurred during field work for train-the-trainer activities carried out under Activity 2.6.

At Goroka, Ms Vincianna Andrew enrolled in an honours program with UPNG to undertake interviews with nursery training participants at Goroka. The interviews sought to provide a family-based background to farmers' motivations. During field work, Ms Andrew has been supervised by UPNG staff. Her paper which deals with this subject was presented at the 2015 IUFRO Small-scale Forestry Conference on Queensland's Sunshine Coast (hosted by USC), is Appendix 11 of this report. An extract from Ms Andrews' Honours thesis is presented as an adjunct to the results of Activity 2.6 in Section 7.

A systematic analysis of factors which affect clan and individual clan member's decision-making and hence their attitudes towards community forestry was published as a research paper in the *Journal of Rural Studies* entitled '*Enabling Conditions for Community-based Reforestation in PNG: The importance of a family-based approach*'. The results of this investigation are also presented in Appendix 12 as an academic paper titled '*Accommodating group heterogeneity in forest landscape restoration'*.

Ona Keto was identified as an additional site in which to conduct research because there had been suggestions that a mechanism had been developed to establish plantations across clan boundaries. A one-week exploratory visit was undertaken to interview stakeholders from various clans and to obtain background on the Ona Keto Foundation (a multi-clan organisation). The social research was carried out in conjunction with a silviculture training exercise for community members. The methodology consisted of informal interviews, community meetings and field visits.

As a contribution to obtaining an understanding of factors affecting decision-making about forests and understanding the value of forests both in social and livelihood terms, in mid-2016 project researchers used the methodology described in Activity 1.2 to undertake a 'forest values and usage assessment'. This activity was part of a larger study which included case studies in Madang. Two village level case studies were carried out in the RMV at Sangkian and Bopirumpun. At Madang, the assessment was conducted at Sogeram. In each case study, workshops, each lasting several hours, were held separately with men and women to identify the products and services they obtain from forests.

A study of factors which could influence women's participation in reforestation projects was undertaken in July 2017. Interviews with nine women and seven men found that women's motivation to be involved in reforestation projects depends on the increased work load it may create, women's traditional lack of secure land tenure and a lack of control over family income and family decision making. Further research is needed to understand how gender issues may best be addressed during these projects.

Activity 2.4 Identify key drivers likely to affect scaling-up success

PNG partners indicated that technology diffusion between clans is often low. Accordingly, in the communities of Musuam, Ragiumpun, Waritzian, Sangkian and Barola, an action-research approach was undertaken to the introduction of small-scale nurseries. This approach is described below as part of the train-the-trainer activities carried out in Activity 2.6. Providing extended extension assistance assisted project researchers to discern key

drivers and requirements for successful community-based reforestation in the RMV and the EHP. These activities were used to identify the style of reforestation (monoculture, mixed species or agroforestry) which was most likely to be acceptable to communities, how the benefits of reforestation might be shared and how intra- and inter-clan negotiations should be undertaken before reforestation occurs.

Activity 2.5 Identify ways to improve access to germplasm

High-quality seedling stock (e.g. for *Canarium ovatum* and *Pometia pinnata*) from the RAIL nursery was used as the initial step in improving high-quality germplasm supply for community plantings. For germplasm of tree and cash-crop species which communities could not access themselves, germplasm was accessed from outside sources, e.g. the PNG Cocoa and Coconut Research Institute.

Activity 2.6 Implement a train-the-trainer program

An assessment of the efficacy of extension activities which were carried out during a previous project (FST/2004/050, '*Value-adding to PNG Agroforestry Systems'*) was undertaken. The principal field-based activity which was carried out in that project and which was relevant to this current project, was training in tree seedling production. It was envisaged that communities would adopt small-scale forestry after training had been delivered and that small nurseries would become a source of seedlings to local communities. Accordingly, project researchers conducted a survey of seven mini- or micro-nursery owners who had started to grow seedlings during or after the previous project. The results of this survey provided the baseline information for subsequent train-the-trainer activities.

At Ramu and Goroka, PNGFA and FRI staff were encouraged to conduct training activities in the manner which they considered to be most appropriate to participant's needs. Hence, different training approaches were used at Goroka for EHP participants, and at Ramu. In Goroka, PNGFA researchers delivered two three-day live-in nursery and silviculture training courses to farmers from the district. These farmers were selected from a PNGFA database of people who had requested seedlings from the PNGFA. The course was designed as competency-based instruction, beginning with seed collection and ending in seedling out-planting. A mixture of lectures and practical exercises gave participants opportunities to learn the principles of nursery management but also to build a clan-based nursery (Appendices 13 and 14). On completion, participants were given shade-cloth and tree seeds and were encouraged to start their own mini-nurseries. Subsequent follow-up visits by FA staff provided further encouragement and technical assistance.

At Ramu, FRI researchers conducted on-site competency-based training in the villages of Musuam, Waritzian, Ragiumpun, Barola and Sangkian, and at the Waterise Primary School and the Kainantu High School. These training sessions involved a total of approximately 100 people. Participants constructed a small nursery and learnt how to raise and out-plant seedlings, and how to undertake site preparation and maintenance.

Activity 2.7 Design and test improved community forestry systems

The initial approach to tree planting at Musuam, Waritzian and Barola focused on woodlots. However, the results of work undertaken as part of ACIAR project FST/2004/050 were used to guide reforestation suggestions to the Purap and Kasiamp clans at Sangkian Village for a fire protection system for small-scale timber plantations. These suggestions included inter-cropping with vegetables and under-planting timber tree species (*Eucalyptus pellita* and *Canarium ovatum*) with cacao. The efficacy of this planting system in providing fire protection will be tested in the period following the 2018 dry season.

Activity 2.8 Monitoring and evaluation of scaling-up activities

It is difficult to monitor and evaluate (M&E) the success of extension activities within several growing seasons of the life of a tree planting project. Hence, the approach was to revisit farmers and communities to assess their progress and enthusiasm. At Ramu, M&E

occurred through visits to Sangkian in July 2017. The follow-up visits have provided information concerning tree growers' difficulties and potential solutions. These are reported in Section 7.

FRI researchers undertook a review of the effectiveness of training delivered to participants who attended Charcoal Producer Training that was conducted under ACIAR Project 'FST/2011/058*; 'Facilitating of Charcoal Producer Groups in PNG'* (Appendix 15).

5.2.3 Objective 3. Analyse policy and institutional systems that can support enhanced implementation of community forestry in PNG

Activity 3.1 Assessment of policy impacts on decision-making by landowners

The methodology for Activity 3.1 and 3.2 first involved a detailed review of policy documents (legislation, regulations, and analysis and commentary) related directly to the forestry sector as well as to other sectors with impacts on forestry (Appendix 16).

The second aspect of the methodology was integrated with the field work undertaken for Activities 1.2, 1.3, and, to a lesser extent, Activities 2.3 and 2.4. The practical impact of current policies was explored through discussions with community members about the factors that affect their decision-making about forestry activities. This issue was an integral part of the investigation of social dynamics and the identification of key drivers that affect the scaling-up of ecoforestry and community-based reforestation (Appendices 17, 18 and 19).

Activity 3.2 Policy workshop to review ecoforestry community forestry policy

Members of the project team presented at each of the three workshops organised by the Forestry Program Manager, which were held during the course of the project. Attendance at these workshops provided opportunities to engage with a variety of stakeholders in discussion of policy relevant to community forestry.

Activity 3.3 Recommendations for institutional arrangements to support community forestry

A review of existing policies and legislation which affect community forestry was used to identify policy recommendations/options and improved institutional arrangements which could support both ecoforestry and reforestation. Further identification and clarification of policy constraints, as well as suggestions about what changes would contribute to improved implementation, was obtained through interviews with PNGFA staff (particularly field staff) and representatives of other agencies.

6 Achievements against activities and outputs/milestones

Objective 1: To enhance scaling up of community ecoforestry in native forests

No.	Activity	Outputs/ milestones	Completion date	Comments
1.1	Analyse value-adding opportunities	Initial training of 16 PNG based research staff.	Dec 2016	Undertaken as a Social Science Training workshop with 16 participants from the FPCD, the PNGFA, the FA Goroka and RAIL. Ongoing mentoring has occurred throughout the project.
		Preliminary identification of value adding opportunities were undertaken and completed.	Aug 2015	
		Financial analysis study.	Feb 2017	Appendix 3
		Report on business case for portable sawmills, centralised marketing units and reduced impact logging.	Feb 2017	Appendices 4, 5 and 6
1.2	Investigate community dynamics	Training of research staff	Feb 2014	Undertaken as a Social Science Training workshop with 10 participants. Ongoing mentoring has occurred throughout the project.
		Field work completed	April 2015	
		Report on critical community dynamics is finalised	April 2017	Appendices 1, 8, and 19
1.3	Identify key drivers likely to affect scaling-up success	Workshop held with s/holders	July 2014	The workshop was abandoned as work with individual groups in Madang continued to provide challenges in terms of identifying key drivers and potentially useful up-scaling options.
		Recommendations for scaling-up initiatives are finalised		Challenges to up-scaling are presented in Appendix 8.

1.4	Implement scaling-up activities	Study tour conducted Design of scaling-up initiatives completed Pilot testing of scaling-up activities commenced	Sep 2015	The study tour to the Philippines and Nepal was replaced with attendance at the 2015 IUFRO 3.08 conference at the Sunshine Coast. No design of scaling-up options was undertaken. No pilot testing of scaling-up activities was undertaken.
1.5	Monitor and evaluation of scaling up activities	Monitoring completed Report prepared which outlines the lessons from scaling up activities with recommendations for future application or modification of these approaches to community forestry		No monitoring or evaluation has been undertaken.

Objective 2: To develop appropriate systems for scaling up of community-based reforestation of grasslands

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Establish field trials to fill critical gaps in technical knowledge	Existing gaps in technical knowledge identified	Aug 2015	
		Field trials established	April 2016	The trials were established by RAIL at Jacob's Creek in the RMV and by the FA at Goroka.
		Weeds controlled at FA Goroka field trial	September 2017	Weed control has been ongoing.
		Report prepared that outlines the lessons from field trials with recommendations for future application or modification of these approaches to community forestry	August 2016	Appendices 9 and 10
		Field trial established at FA Leron		The field trial which was to have been established by the FRI at Leron has not been established.
2.2	Assess potential markets	Initial training of research staff		No training which specifically related to an assessment of potential markets was undertaken.
		Preliminary market assessment undertaken	Feb 2017	
		Business case and financial analysis completed		Undertaken as part of Activity 1.1.
2.3	Understand community dynamics	Training of research staff	Feb 2014	Undertaken as a Social Science Training workshop with 10 participants. Ongoing mentoring has occurred throughout the project.
		Field work completed	Dec 2016	
		Report on critical community dynamics is finalised	Jun 2017	Appendices 1, 12 and 19.

2.4	Identify key drivers likely to affect scaling-up success	Workshop held with s/holders Recommendations for scaling-up initiatives are finalised	 Nov 2017	The workshop was not held. Extensive interviews were held with community leaders and clan members. Addressed in Appendices 1 and 12
2.5	Identify ways to improve access to germplasm	Pilot testing of germplasm scaling-up initiated	April 2016	Access to germplasm was improved via the field trials at Goroka and environmental plantings undertaken by RAIL.
2.6	Implement a 'train the trainer' program	Existing gaps in knowledge identified Program developed Program delivered to trainers Follow-up extension advice provided	June 2014 Sep 2014 June 2015 August 2017	 Separate programs developed and delivered by project staff in the RMV and by the FA Goroka in the EHP (see Appendices 13 and 14). Follow-up extension assistance continued at Sangkian and at Goroka until late 2017.
2.7	Design and pilot test improved community forestry systems	Study tour conducted Report outlining community forestry systems suitable for Eastern Highlands and RMV Pilot trials established for fuelwood/charcoal in Ramu Valley Trials established with two communities Survey of effectiveness of previous 'train the trainer' activities carried out as part of FST/2006/088	Sep 2015 Oct 2017 Aug 2016 Aug 2016 Oct 2016	The study tour to the Philippines and Nepal was replaced with attendance at the 2015 IUFRO 3.08 conference on the Sunshine Coast. Six participants from the FRI, FA Goroka, the FPCD and RAIL attended and presented papers. Addressed in Appendices, 1 and 12. Pilot trials established as woodlots at Waritzian, Musuam and Sankian villages This Activity is now reported under Activity 2.6.

2.7	Design and pilot test improved community forestry systems (cont)	Report and academic paper on the effect of a patriarchal society on decision making and resource sharing arrangements between family groups. Academic paper on the importance of using an anthropologically-guided approach to community forestry in PNG	June 2017 Nov 2017	Appendices 1, 12 and 20.
2.8	Monitor and evaluation of scaling up activities	Monitoring completed. Report prepared which outlines the lessons from scaling up activities with recommendations for future application or modification of these approaches to community forestry		No monitoring and evaluation of scaling-up activities has been undertaken.

Objective 3: To analyse policy and institutional systems that can support enhanced implementation of community forestry in the PNG

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Assess policy impact	Report on impact of policies on community and smallholder decision-making	Mar 2017	Appendix 17
3.2	Review policy	Report on proposals for ecoforestry and community forestry policy review	April 2017	Appendices 16 and 18
3.3	Develop recommendations	Develop communications plan Report on recommended policy change	August 2015 Feb 2017	Project reports and papers have been published on the PIP website. Reported as policy options in Appendix 18.

7 Key results and discussion

7.1 Objective 1. Enhance the scaling-up of community ecoforestry in native forests

Activity 1.1 Analyse value-adding opportunities

Research at Madang illustrated the challenges in attempting to implement or scale-up ecoforestry via community forestry. Research in Awane ceased due to a lack of interest by community leaders in working with the project in the absence of project-provided resources. Because the Dawen group (Aronis Village) expressed interest in obtaining a portable sawmill, project staff were able to conduct interviews with villagers there and supplement these interviews with information from FPCD staff, timber retailers and PNGFA staff. The results of these interviews and a review of PNGFA policies and regulations, provided a clearer picture of the difficulties faced by clans in managing their own forest resources.

Results of the financial analysis

The key result of the financial analysis (Appendix 3) was that the net present value (NPV) of small-scale selective harvesting of 200m^3 per annum for 25 years by the resource owners, was positive for most years but became negative whenever equipment replacement was necessary. As expected, the NPV, was highly dependent on interest discount rates, lumber recovery and annual milling capacity. Variation in lumber species and wood qualities and hence the marketability of the lumber would also drastically affect profitability. In contrast, selling logging rights to commercial companies is highly cash-flow positive, but the forest would be left in a degraded state and forest resource owners (FROs) would lose access to many of the forest products which they normally source from the forest. The importance of these products to villagers is described under Activity 1.2.

The Problem Confronting FROs in PNG

The investigation into the legal constraints for villagers who wish to self-manage their forest, also followed a hypothetical decision by FROs to either clear-fall or selectively harvest their forest (Appendices 4, 5 and 6). The investigation found that assuming larger-scale harvesting is involved, (e.g. a round-log volume of more than 5000 m^3/year), the logging will generally be undertaken through a process involving three parties. The FROs contract the PNGFA and transfer the logging rights to them. The PNGFA subsequently contracts with logging companies to harvest the logs. Payments of royalties are made when the logs are loaded on a ship for export. If smaller volumes (i.e. a round-log volume of less than 5000 m^3/year) are available, or if FROs opt to harvest or process the lumber themselves, the scenario changes. In principle:

- Landowners can harvest timber for their own domestic use without PNGFA authority;
- All harvesting for commercial purposes (whether for domestic or international sale) requires the landowner group to carry out operations under an approved Timber Authority (TA), either on their own or in association with other groups or companies operating with an approved TA;
- TAs require a security deposit of K20,000 to be lodged with the PNGFA;
- Groups can become part of a TA with other groups, but the forests must all lie within a limited 10km radius; and
- In order to be part of a TA associated with a commercial logging operation, it is preferred that landowner groups be registered as Incorporated Land Groups (ILGs[4].)

[4] The legislation regulating ILGs is the Land Groups Incorporation Act 1974, subsequently amended in 2009. This requirement arises under an amendment, but it has not been fully implemented.

Overall, these policies establish a substantial barrier for landowner groups to engage in legal commercial forestry on their own land. The same rules apply for commercial operations and smallholder (clan-based) forestry.

Results of the market analysis for self-milling

Research into self-milling indicated that self-milling is not a simple solution. If FROs opt to selectively harvest and self-mill their forest resource with a view to supplying the market with green-sawn lumber, value-adding activities could theoretically be added at a later stage. The aim of self-milling would be to harvest the forest resource on a sustainable basis and to bring a broader environmental and community/cultural view to the milling activities. Unfortunately, although six NGO-supported portable sawmill operations were identified, some of which had been operating since the 1990s, all operations had ceased once financial support ceased. Community-operated portable sawmills were unable to meet the product quality and quantity requirements of purchasers.

The market analysis which was undertaken to assess the potential demand for rough-sawn green lumber in Madang found that the two primary market segments are the domestic market in Madang[5] and the export market to Australia. Interviews with lumber retailers indicated that there are two grades of lumber, i.e. 'A'-grade and 'B'-grade lumber. A-grade lumber are defect-free. B-grade lumber may not have precise dimensions and may have some defects such as knots, wane, checking, warping or cupping. Most A-grade lumber is exported and most B-grade lumber is sold locally.

Little research has been conducted on the domestic lumber markets in PNG, but Hunt (2000) reported that it is relatively small and easily saturated. Lumber is sold to small businesses in the cities or to local people residing in the rural areas. Prices received in the domestic market can be hundreds of Kina lower than prices that could be achieved from exporting (Bun and Bazakie, 2006). The wood product industry in Madang can be separated into 6 sectors; industrial sawmills, the informal sector (portable mills), secondary processors, retail hardware stores, construction companies, and small-scale carpenters.

There are only two industrial sawmills in the vicinity of Madang, i.e. Madang Timbers and Santi Forestry. These companies primarily export raw logs, but also have fixed-site sawmills. Unfortunately, project staff were unable to find data on the volume of lumber that these mills produce annually and which is marketed to construction companies and local retail hardware stores. In addition to the two main sawmills, 'informal' harvesting and processing occurs by small-scale operators who use portable sawmills. These operators are primarily focused on milling high-value trees and delivering the milled lumber to outlets via personal vehicles or rented Public Motor Vehicles. The vast majority of informal sector operations are technically illegal, because the operators do not have a TA. As there is no way to monitor these operations, the annual harvest volumes are unknown. The manner in which they service secondary manufacturers and small-scale carpenters was also difficult to assess. Interviews revealed that Divine Word University (DWU) is a regular customer, and purchases approximately 600 m^3 per year of milled lumber from the informal sector, Only A-grade lumber is purchased and approximately 75 percent of the lumber is cut from *Intsia bijuga* (Kwila) old growth trees.

Secondary processors in Madang also manufacture products such as furniture, flooring, weatherboards and coffins. While it appears that many of these businesses used to receive a large portion of their lumber from the informal sector, the majority of the secondary processors are no longer in business. All of the remaining secondary processors that were identified purchase all of their lumber from retail hardware stores. In turn, hardware stores and construction companies, almost always purchase lumber from the two industrial

[5] In this instance, Madang refers to the Madang District, which includes the urban city of Madang and the Ambenob and Transgogol rural areas. It does not refer to the entire province of Madang, which includes 5 additional districts.

sawmills. This is because large orders of specific dimensions can be processed and the quality of the lumber is consistent.

Small-scale carpenters in Madang are primarily focused on building semi-permanent and permanent timber frame homes for people living in the rural areas of the district. The small-scale carpenters that service this market primarily purchase B-grade lumber from the informal sector. Hence, for FROs who wished to engage in ecoforestry and self-milling, the most appropriate target market in the Madang District would be the either small-scale carpenters or the DWU.

Estimates of the annual lumber requirements of Madang to build new homes (Figure 2, Table 1) is approximately 800 m^3, including the 600 m^3 of A-grade lumber purchased by the DWU and 200 m^3 of B-grade lumber which is purchased by local carpenters.

Figure 2: Timber frame home under construction in the rural region surrounding Madang.

Table 1: Estimated lumber demand for small-scale carpenters producing timber frame homes.

	2017	2018	2019	2020	2021
Total new home construction in rural Madang district	540	559	578	597	641
Number of new timber frame homes (10.1% of total)	55	56	58	60	65
Volume of lumber needed for timber frame homes (m^3)	186	192	198	205	220

DWU staff indicated that the University is consistently offered more lumber than it needs and often turns informal sector operators away. As the University represents approximately 75 percent of the domestic market, it seems that the supply may already be exceeding demand. It appears that the assertion of Hunt (2000), that the domestic market is small and easily saturated, continues to hold true.

Export markets

Several studies have suggested that the best opportunity for eco-forestry to succeed in PNG is to pursue the high-value export market (e.g. Hunt, 2000, Fox et al. 2011, Grigoriou, 2011). Industrial economies like Australia have a high demand for A-grade tropical hardwood, and high profit margins could be made if the international buyers believed that they were buying a unique product with a value beyond functional utility (Fox et al. 2011).

At Madang, the peak export volume of ecoforestry lumber occurred in 2008, through the work of FORCERT (Ericho et al. 2013). After the FPCD achieved FSC certification, it was able to export approximately 64 m^3 of lumber to Australia before their certification expired.

Until recently, the primary importer of PNG lumber has been 'Woodage', a wood product distributor located in New South Wales, Australia. However, in recent years the company has altered its business model to focus on supplying lumber to larger businesses. The shipments that it previously received from PNG contained lumber volumes that were too small, too sporadic, and had too much variation in quality to satisfy the needs of these larger business customers. Other importers of PNG ecoforestry lumber have reportedly previously expressed similar concerns. Unfortunately, project staff were not able to identify the name and location of these other importers.

Markets for sawlogs in Lae

The market for sawlogs and lumber in Lae was investigated using a local lumber yard as a case study. Project researchers found that the lumber yard harvests and mills timber on land owned by forest-dwelling communities utilizing chainsaws and portable sawmills. The sawmills are operated by employees who have been professionally trained in felling and milling activities at the Timber and Forestry Training College in Lae. Sawn flitches are transported to a manufacturing facility in Lae where additional value-adding activities are conducted. The milled lumber is manufactured into tongue and groove flooring, weather boards, moulding and treated timbers. These wood products are then sold to various hardware stores throughout PNG. The business does not obtain a TA permit for prior to harvesting. The price paid to the forest landowner varies by timber species and was quoted as being in the range of K700 – 1,200 per m^3 for sawn lumber. The business owner stated that this amount is comparable to the prices that forest landowners would receive if they milled the timber themselves and transported it to the nearest lumber market. However, the price is very sensitive to transport costs. Small volumes of logs in remote locations are uneconomic to harvest. For FROs, these prices are very favourable compared to large-scale harvesting by foreign companies. Even allowing for a round log volume to sawn lumber recovery rate of 30%, the price paid by the lumber yard owner is much higher than the averaged stumpage-based royalty paid to FROs from large-scale logging companies of approximately USD6 per m^3. Proportionally, the price paid by the lumber yard owner is also much higher than the average return to FROs of 6.2% of revenue from large-scale harvesting (Appendix 5). The business case of this operation could not be triangulated to other sources. However, the study illustrated that first, that there is a market for sawlogs located close to Lae. This market is already being met by local processors. Second, these processors may operate without mandatory permits such as a TA. Finally, communities wishing to harvest native or plantation timber would be in direct competition with existing processors.

Summary

For this activity, the summarised findings are that it is very difficult for customary land owners, as smallholders, to legally engage in ecoforestry. Both current legislation and market factors are major impediments. While there may have been opportunities for ecoforestry groups to export lumber from PNG to Australia in the past, there are currently no known interested buyers. It appears that the primary challenges that need to be addressed before approaching this market again are to establish consistency in lumber quality, volume and timely delivery. Unless FROs can negotiate with a private portable sawmill operator to cut and mill their timber, they have little option but to accept the much lower royalty rates offered by large-scale foreign companies.

Activity 1.2 Understand community dynamics in relation to ecoforestry

Between 2014 and 2016, project researchers visited communities to gather information concerning the community dynamics that would affect the uptake of ecoforestry. Five communities which had previously been involved in ecoforestry with the FPCD were used as an initial source of information to explore potential value-adding opportunities. However,

soon after project inception, it became apparent that the FPCD had effectively ceased to operate in Madang Province. Of the five communities which were originally involved in FPCD operations, research focused on three communities (as case studies) which had ongoing activities.

Case 1: An operating ecoforestry activity
In this community, the ecoforestry group had a portable sawmill which had been borrowed from the FPCD. The group had successfully harvested and sold timber in Madang, although the business was not robust due to low prices and inconsistent demand. The operation was operated as a private business by a small number of kin, rather than by the clan as a whole. The activity was clearly not a collective effort by the clan, but a business operated by some clan members.

Case 2: Decision-making about alternative uses of clan forest for ecoforestry or industrial logging
In this case, the clan involved was very small, consisting of a number of brothers and their families. One of the younger brothers was attracted to ecoforestry because it reflected greater respect for the spiritual values of the forest than commercial logging. His brothers, who did not live on clan land, preferred the option of obtaining royalties by allowing commercial logging. However, they deferred to his wishes as he lived within the clan land and because of his connection with forest spirits. Although not the senior brother, his personal influence effectively made him the clan leader. With the assistance of one other member of the group he had been involved in some harvesting, but the activity had not proved financially viable. As hopes of making significant income from ecoforestry did not eventuate, a compromise was reached whereby a portion of the clan land would be provided to commercial loggers. This solution itself became problematic due to a long-lasting dispute with a neighbouring clan who had use rights to part of the land proposed for logging. This dispute, arising from murders decades earlier, required a costly customary ceremony in order to be resolved. Resolution of the issue is still pending. Again, in this case, the economic activity was not whole-clan based.

Case 3: A strong leader with an interest in village development
The third community involved a clan which had cut, processed and sold timber with assistance from the FPCD. However, when the financial capacity of the FPCD to support harvesting ceased, timber operations also ceased. The most prominent member of the clan attempted to obtain a portable sawmill, but was unable to obtain finance. He was unwilling to pursue options to purchase equipment jointly with other groups or to employ external mobile sawmill owners for harvesting. It was clear that he had wide support within the clan for his overall goals, but, again, only a small number of clan members were actively involved in forestry activities.

Summary of the three case studies
The three case studies demonstrated that economic activities tend to involve small members of kin (e.g. 2-5) and that clans (as a whole), do not normally engage in economic activities (Appendix 19). However, clan leaders decide what activities may be allowed on clan land, so clan support is required for ecoforestry activities. This finding is consistent with anthropological literature on the function of clans. It has implications to efforts to promote community forestry as a clan or multi-clan activity and suggests that negotiating land use needs to involve the clan as a whole, whereas specific activities should generally be promoted through smaller family or extended family groups.

Results of the Forest values and usage study
The forest values and usage study (Appendix 7) provided information concerning villagers' dependency on their gardens and adjacent forest. Valued items from forests included food items, sometimes with great variety. Valued products and services identified by men and women also included products and services related to spiritual, religious and aesthetic. In summary, the study indicated that forests are important to these villagers, in many and various ways.

Activity 1.3 Identify key drivers likely to affect scaling-up success;
Activity 1.4 Implement scaling-up activities;
Activity 1.5 Monitoring and evaluation.

It was originally expected that data collected during Activities 1.1 and 1.2 would facilitate monitoring and evaluation of scaling-up initiatives in the five communities in which the FPCD had worked. However, project researchers found that the effect of PNGFA policies has been to establish a high, perhaps prohibitive, barrier for landowner groups who wish to engage in commercial forestry on their own land. In practice, informal and small-scale logging by clans occurs. This situation is tolerated by the PNGFA, probably because it is too difficult to enforce the laws/policies. However, such 'informal' small-scale harvesting has a limited market and prices are low. Given these circumstances, it was not possible to model barriers to scaling-up ecoforestry, or to implement, monitor or evaluate scaling-up activities.

7.2 Objective 2. Develop appropriate systems for the scaling-up of community-based reforestation of grasslands

Activity 2.1 Establish field trials to fill critical gaps in technical knowledge

At both Goroka and the RMV, species trials were delayed by the severe drought of 2015 and early 2016. Hence, by mid-2017, the trees were too young to assess growth trends and suitability for widespread tree planting. Although these trials serve a scientific purpose they have also proved useful during field days with local villagers.

The field trial at Goroka
In May 2016, the trials were established on two blocks of land, each measuring 60m x 60m. Seedlings were planted on 26-27 May 2016. As at March 2017, the survival of the trees is approximately 95% and growth is excellent (Table 1). A neighbouring clan has been contracted to slash weeds. This species trial will provide important information for prospective tree growers at Goroka. However, further trials are needed to test a wider range of tree species and growing conditions.

Table 1. Average diameter (ground level) and average height of four tree species at one-year of age at Goroka

Species	DGL[6] (mm)	Av Height (cm)
Acacia mangium	8	31
Swietenia macrophylla	13	94
Eucalyptus grandis	13	94
Agathis alba	7	33

The Jacob's Creek field trial in the RMV
The field trial was inundated after heavy rain in early 2016. Although the trial is too young for growth trends to emerge, survival and growth of some species on this soil type already provides an indication of its suitability (Table 2). To assist data analysis in the future, data collected in August 2017 is being managed as a Microsoft Access database.

[6] *Diameter at ground level*

Table 2. Survival and height growth of trees at the Jacob's Creek trial at two-years of age

Species	Survival (%)	Mean Height (m)
Acacia mangium	6%	2.00
Aleurites mollucana	34%	1.35
Alstonia scholaris	36%	0.92
Araucaria cunninghamii	2%	0.70
Bischofia javanica	46%	0.97
Elaeocarpus sp.	16%	0.61
Eucalyptus deglupta	42%	1.59
Ficus sp.	32%	1.20
Gnetum sp.	2%	0.52
Haplolobus sp.	6%	1.18
Horsfieldia irya	40%	1.24
Intsia bijuga	8%	0.46
Myristica hollrungii	6%	0.56
Nauclea orientalis	52%	1.65
Planchonella sp.	66%	1.31
Pterocarpus indicus	62%	0.90
Sterculia sp.	48%	1.10
Syzigium sama	6%	0.80
Terminalia microcarpa	38%	1.31
Tristiropsis acutangula	0%	NA

The field trial at Leron

The field trial which was to be established by the FRI at Leron did not proceed. Permission to use the land for a field trial was not granted by the PNGFA until late 2016 and it was decided to redesign the trial for incorporation in a follow-on ACIAR project.

Activity 2.2 Assess potential markets

The investigation into market opportunities in the RMV or Eastern Highlands for small quantities of either high- or low-value sawlogs or poles was curtailed because the high cost of transport (approximately K3000 per truck load) between Lae and Ramu is prohibitively expensive. The highway between Goroka and Lae is in such poor condition that (already

high) transport costs are continually escalating and becoming a barrier to industry development. A further distortion of the market for low-quality timber is that 'PNG biomass' is currently planting large areas of *E. pellita* for woodchip. Project staff noted comments from villagers that their clan would lease land to PNG Biomass for large financial rewards. Until the business model (e.g. land rent) of PNG Biomass becomes clear in the next few years, this company's operations are distorting villagers' perceptions of the financial returns from tree planting. Project staff also reported that villagers were adopting a 'wait-and-see' attitude to PNG Biomass activities.

Markets for E. pellita sawlogs at Ramu

At Ramu, project staff found that there was little marketing opportunity for small volumes of logs. The RAIL sugar refinery purchases only approximately 50 tons of firewood annually. There is no local market for firewood at Ramu, unlike Goroka, where firewood is widely sold in the marketplace.

Summary of potential markets for sawlogs

The lack of a market in Ramu indicated that there is little point (at present) further investigating the market for high-value sawlogs. In any event, the large-scale *E. pellita* plantations of PNG Biomass are likely to fill any requirement for sawlogs in the RMV.

Activity 2.3 Understand community dynamics in relation to reforestation

Rather than being undertaken as a separate activity, understanding community dynamics in relation to reforestation was underpinned by the results and findings of extension activities which were undertaken (and reported) as part of Activity 2.6. The different extension approaches used in the RMV and at Goroka provided complementary outcomes in relation to addressing community needs. The live-in courses conducted at Goroka were expensive, but they provided training to approximately 15 people per course – and these people had already professed interest in growing trees. An alternative approach using community nurseries was used at Ramu and provided training for any community member who wished to attend.

Project researchers were successful in assisting villagers to establish a woodlot at Waritzian, but a proposal to establish a species trial there caused intra-clan tensions to flare and staff have not been able to return. Similarly at Ragiumpun, a community nursery which was supplied to a cocoa cooperative of six clans, was also abandoned when conflict flared. Project staff were refused entry to Ragitzaria because of inter-clan antipathy. Complementary results occurred at Musuam and Barola, when 'community' nurseries were taken over by one family. At Sangkian, extension activities proved successful but again, the Purap and Kasiamp clans refused to work together. Underplanting *E. pellita trees* with cacao proved successful in motivating people to plant trees. However, using vegetable planting as a surrogate for intensive weed control (to prevent fire) proved unsuccessful. This was because weed control is considered a women's activity and the extra weeding imposed an unfair burden on them. They consequently reduced the area of land which was planted to an insignificant level.

Insights from providing extension assistance to communities reinforced the appropriateness of a family-based approach rather than clan-based quasi-collective action (see Appendix 1 and 12). Although obtaining entrance to communities will always be achieved through community leaders, extension assistance should be given to individual families. Collective action is not a normal mode of action for economic activities in clans and research-for-development activities should not try to create an institution which has not existed before. There are several widely acknowledged aspects of clan society (e.g. defence) which engender collective action, but tree planting is not one of them. These results indicate that extension activities should concentrate on those communities that are receptive (i.e. clan leaders welcome outsiders) and are socially stable. Unfortunately, the operational and financial efficiency of a family-based extension approach may not be possible.

These results are in accord with anthropological research that clans are not stable institutions, if indeed they ever were, and leadership is often achieved rather than inherited (Bonnell, 2012). Out-marriage and adoption result in a steady stream of outsiders into communities and forging of new alliances (Barker, 1990; van Helden, 1998). In some clans, families may relate more to 'security circles' which successively encompass livelihood activities with kin, in-laws, and gardening, hunting and trading partners, rather than bloodlines (van Helden, 1998 p.158; Weiner, 2013).

The results of this project also indicate that further research is needed relating to the effect of new farming systems on women's workload and their status in households. At Sangkian, under-planting trees with vegetable crops achieved little except to reduce the area of land which was planted. Assisting male farmers to plant cacao also reinforced the primacy of their role as decision-makers in households, because they will control the income from the crop. These results were reinforced by the preliminary study of factors which could influence women's participation in reforestation projects. It was found that women's motivation and capacity to benefit from tree-based projects depends on their work load. The dry season (approximately March to October) is the busiest time in women's calendar, hence they have little interest in nursery activities during that time. Fetching water for a nursery can become a major chore. A general problem also relates to women's lack of power over family income and their inability to inherit land. Hence, women are ambivalent about reforestation, unless it can directly ease their responsibilities for finding and preparing food.

From a community dynamics perspective, adopting a family-based approach to extension activities may motivate some of the less-powerful members of clan society. In the EHP, people may use tree planting to create land ownership boundaries and establish usufruct rights. Similarly, in the RMV, people may use tree planting to begin the inter-generational process of establishing rights to land for their children. Permission from clan leaders to use land for long-term purposes will still be required. Also, unless a gender-specific approach to tree planting is undertaken, the benefits of tree planting may be captured by men. Further research is required into how women and less-powerful people in villages can be motivated to become involved in tree planting activities.

Activity 2.4 Identify key drivers likely to affect scaling-up success

For Activity 2.4, observations made during extension activities indicated that four key drivers will be critical to scaled-up small-scale forestry in communities. Further research is needed to verify how these drivers can be applied over a range of locations and socio-cultural contexts.

First, in the RMV, socio-cultural issues, particularly intra- and inter-community conflict, are far more important than biophysical issues such as the availability of seed. Biophysical issues are more easily remedied, whereas a favourable social environment requires a domain of pre-existing or socially malleable conditions which can be managed through extended social preparation and assistance. However, villagers are unlikely to welcome extension staff meddling in their internal affairs. Community harmony and stable leadership are therefore prerequisites for scaling-up.

Second, both socio-cultural and biophysical issues are situation-specific. For example, the privatised nature of land holdings in the EHP, as shown by their use of trees as boundary markers (see Activity 2.6), may serve as an opportunity to promote tree planting. The availability of seed which was relatively unimportant in the RMV, emerged as a critical factor in remote villages of the EHP. Hence, the key drivers which affect scaling-up are likely to be situation- or clan-specific. Assessing the needs of each community may be an extended process.

Third, inter-planting trees with vegetables or other similarly intensive agricultural systems may have unintended consequences for the division of labour between men and women. A key driver for tree planting may be the usefulness of trees as a cover crop for cacao or coffee, but this would reinforce control of family finances with men. There is a further danger

that farmers' mental model of the farming system could be dominated by the cash crops and that the role of trees would be diminished. For example, farmers may opt to use *Gliricidia sepium* as an alternative to other multi-purpose trees for the over-wood component of cacao or coffee-based agroforestry. Although this research has found that cash crops are a key driver to scaling-up tree planting, there is a danger that tree planting (except for *Gliricidia*) may be sidelined. This aspect also warrants further investigation.

Finally, woodlots and boundary markers may be a motivation for some farmers, but multi-purpose trees may open another window of opportunity for small-scale forestry. Multi-purpose farming systems are not new and are described by Mulung et al. (2011). The manner in which *Canarium ovatum* seedlings were immediately appropriated by villagers at Sangkian was typical of PNG villagers' widely known interest in agricultural matters. This research indicates that tapping into this enthusiasm for new plants may be a key driver for engaging with communities. In the RMV, scaling-up is unlikely if extension activities are restricted to *E. pellita*.

Negative factors also emerged throughout the timeframe of the project. These negative factors are quasi-collective action which leads to asset appropriation by clan leaders, insecure land and usufruct rights, intra- and inter-clan violence, and in some cases in the RMV, alternative timber supplies from PNG Biomass plantations.

A further finding which emerged from this research was that individual adoption of technology may occur but cross-family diffusion may be low. Collective action is unlikely, and scaling-up may be best achieved through a clientele of motivated or 'champion' farmers who may influence others. However, because farmers are traditionally reluctant to share technology outside of their immediate family circle, extension activities will necessarily be repeated many times and material assistance should be designed for individual families. In practice, this may mean a focus on small-group and individual tuition and for example, micro-nurseries rather than community-based nurseries.

Activity 2.5 Identify ways to improve access to germplasm

In relation to Activity 2.5, the results indicate that genetically superior germplasm of *E. pellita* is now widely available. The widespread expansion of PNG Biomass plantations of this species in the RMV provides a ready source of seed. High-quality seedling stock (e.g. for *Canarium ovatum* and *Pometia pinnata*) from the RAIL nursery was used as the initial step in improving high-quality germplasm supply for community plantings. For germplasm of tree and cash-crop species which communities cannot not access themselves, germplasm will need to be accessed from outside sources, e.g. the PNG Cocoa and Coconut Research Institute.

The high early-age growth of environmental plantings undertaken by RAIL will provide a seed source in future years. Of their own accord, RAIL staff are trialling 68 native tree species in buffer plantations which serve as a buffer to oil palm. Although they have not been planted as formal scientific trials, and young trees are susceptible to arson, the surviving trees will provide a seedbank for the future. Early results of the species trials indicate that farmers should not be encouraged to grow *Intsia bijuga* because of its poor growth performance in plantations. Genetically superior teak germplasm was not trialled in this project because research into road transport costs had indicated that there was little market opportunity for small volumes of teak logs in the RMV.

Farmers' motivation to grow trees is also influenced by the availability of coffee or cacao seedlings. Hence, the opportunity to increase tree planting, via its usefulness as a shade crop, is predicated on providing expensive cacao seed. Unfortunately, this shifts farmers' agricultural system away from agroforestry towards cacao. Further research into the importance of this shift will be undertaken in the follow-on project 'FST/2016/153 *Enabling Community Forestry in Papua New Guinea*.

Activity 2.6 Implement a 'train-the-trainer' program

Extension activities which underpinned Activity 2.6 are comprehensively reported in Appendices 1 and 12. The results of this project corroborate the general insecurity experienced by clan members, as reported by Mulung (2012), regarding land tenure and usufruct rights.

Background information contained in previous ACIAR project final reports
The final reports of FST/2004/050 (Kanowski et al., 2014) and FST/2006/088 (Nuberg et al., 2013) contained findings and recommendations for action or further research. Several of these findings and recommendation were applicable to this project. In particular, these previous projects found that farmers are handicapped by limited knowledge of raising and managing tree species; the current lack of government sponsored extension assistance is hindering adoption of tree growing by PNG landowners; further research is needed into appropriate extension methods for Melanesian culture; and very little is known about farmers' decision-making processes. Confirming the veracity of these findings provided avenues of investigation for this current project.

Following up field-based activities carried out during FST/2004/050
The principal field-based activity carried out in *FST/2004/050* which was of relevance to this current project was training in tree seedling production. It was envisaged that communities would adopt small-scale forestry after training had been delivered and that small nurseries would become a source of seedlings to local communities. Accordingly, project researchers conducted a survey of seven mini- or micro-nursery owners who had started to grow seedlings during or after the previous project. The specific objectives of the interviews were to:

- Ascertain the characteristics (number, size, purpose, infrastructure) and seedling quality of micro-nurseries adjacent to the town of Ramu;
- Assess farmers' current self-efficacy in raising and out-planting seedlings;
- Assess farmers' willingness or enthusiasm to adopt technological improvements which are presented to them through further extension activities;
- Ascertain within- and cross-clan seedling dispersal.

The surveys found that the micro-nurseries had a capacity to grow only several hundred seedlings per annum. The owners were growing seedlings as a hobby and in several instances had given seedlings to their relatives. They expressed little interest in selling seedlings in a local market. Seedling quality in these nurseries was universally poor, with seedlings being grown on bare dirt thereby allowing roots to grow down into the soil. Variation in seedling height and health was high. In general, the interviews indicated that after FST/2004/050, adoption of tree growing technology has been very low and only a few geographically-scattered farmers are still growing seedlings. Diffusion of tree growing technology to other farmers was therefore likely to be low.

These initial findings provided the backdrop for 'train-the-trainer' and direct assistance activities.

Undertaking extension activities in the RMV
In the RMV and at Goroka, project researchers used small-scale forestry as the technology and nursery extension as the means for accessing communities and providing assistance. This provided insights into farmers' reforestation decision-making.

For four case studies of communities' reaction to extension assistance, i.e. at Waritzian Musuam, Borola and Ragiumpun villages, project staff used a mixed-methods approach to data collection, including qualitative information (i.e. what farmers said), combined with visual observations and descriptive statistics of what they actually did. Data collection began in late-2014 and continued until mid-2017. Using the results of the four case studies as a guide, a fifth case study was undertaken at Sangkian. The main difference between the first

four case studies and extension activities at Sangkian was a shift from *E. pellita* woodlots to using trees as an over-story for cacao.

In all five communities, project researchers first conducted meetings with interested people, followed by training in nursery techniques, and follow-up visits to provide advice and to allow opportunities for dialogue (Figure 3). Material assistance was restricted to the supply of shade-cloth, a wheelbarrow, spade, plastic seedling bags and an initial small quantity of seed. Extension assistance included a declared exit strategy, i.e. community members were advised that the purpose of the assistance was to allow them to develop self-efficacy so that further external assistance was no longer necessary.

Project researchers also held two field days in conjunction with RAIL for community representatives from the villages of Waritzian, Musuam, Ragiumpun and Sangkian (Figure 4). The field day had a dual purpose. Firstly, it sought to establish lines of communication with participants and secondly, to demonstrate the feasibility of growing tree seedlings in small community nurseries and then establishing seedlings in the field. Separate on-site nursery training was also held at Borola village at Kainantu.

Figure 3. Ms Melinda Thom of RAIL conducting a community meeting at Sangkian

Figure 4. Villagers discussing woodlot establishment at a field day.

Nursery extension initially proved successful at Waritzian, Borola and Musuam. Project workers were welcomed into the community, nurseries were established and seedlings were grown and out-planted. However, at Waritzian and Musuam, as extension activities continued, ownership of the community nursery collapsed to one family or small group and tree planting dwindled. In each case, planting has been limited to hundreds seedlings rather than thousands. At Barola, ownership of the community nursery has passed to one individual farmer who has grown several thousand seedlings for sale in the local market. At Ragiumpun a multi-clan cocoa cooperative collapsed due to inter-clan conflict. The nursery has since been taken over by one clan. Community disharmony resulted in project researchers being excluded from Ragitzaria

In these latter two communities, it appeared that intra- and inter-community conflict concerning resource sharing – particularly land – acted as a major impediment. Project researchers also commented that at Musuam, Ragiumpun and Waritzian, they typically met new villagers at each visit. They interpreted this as being an indicator that people's interest was piqued by extension activities, but they were not able to be included. Biophysical issues proved to be much less important. At Waritzian and Musuam, project researchers found that villagers readily adopted nursery and out-planting technology. After villagers were shown where and how to collect seed of the most preferred species, *E. pellita*, they were able to collect it for themselves.

The key result which emerged from subsequent extension activities at Sangkian was that community conflict, as in other communities, became a major impediment. Despite extensive community preparation and negotiation, project researchers were informed in mid-2017 that a dispute over the funding had developed and that some villagers had threatened to burn newly planted *E. pellita* seedlings.

Under-planting tree seedlings with vegetables also failed because maintaining vegetable gardens is the responsibility of women. Planting tree seedlings increased the area of land for them to manage and produced a surplus of vegetables which they would have to sell in the local market. Women at Sangkian consequently reduced the area of land planted with trees to only several hundred square meters per family.

Under-planting tree seedlings with cacao seedlings was more successful, with the caveat that genetically improved cacao seed which was sourced from the Cocoa and Coconut Research Institute in Madang was very expensive - approximately 25 PNG *toea* or 12 Australian cents per seed. Buying the seed was also not simple because certificates of fumigation were required to transport the seed from Madang to Ramu and the seed had to be personally collected. Fortunately, no problems were experienced in raising cacao seedlings. Villagers were very enthusiastic about under-planting *E. pellita* with cacao, but some of them opted to use *Gliricidia sepium* as an alternative shade tree. Gliricidia grows readily from cuttings, but its wood qualities and form are very poor, hence growing it as a shade species eliminates tree planting, *per se*, as a project objective. A further complication was that villagers described cacao planting and harvesting as an activity undertaken by males. Women are therefore potentially excluded from the benefits of cacao plantations.

Undertaking extension activities at Goroka

A different extension approach was employed at Goroka. In November 2014 and March 2016, two live-in train-the-trainer courses of three days duration were conducted for a total of 31 representatives from communities, schools and community-based organizations from the EHP. The purpose of the training was to provide participants with the set of skills and knowledge which would allow them to establish and manage a small-scale timber tree nursery on their own land. The training was delivered as lectures and practical sessions with hands-on training, supplemented with a training manual. Farmers received training in seed collection, preparing nursery beds, soil sterilisation, and germinating and out-planting

seedlings. Farmers were also supplied with seed, shade-cloth and polybags to start their own home nurseries.

The results of the training were assessed via follow-up interviews which found that following the training, 70% of participants constructed nurseries and grew seedlings. Of those participants who grew seedlings, most of them had given seedlings away to family members and 30% had sold seedlings. However, in the EHP access to seed is a major problem which would prevent participants from continuing to grow seedlings.

A further result which will affect tree planting in the EHP was that approximately 30% of participants had planted seedlings as woodlots but 44% had used seedlings to demarcate land boundaries. The purpose of both planting styles had more to do with land tenure security than tree planting *per se*:

> 'Farmers use trees as boundary markers as a form of security for the inheritance of their land. In the Eastern Highlands (as elsewhere in PNG) clan-owned land was originally available for any member of the clan to carry out subsistence gardening. Villagers accessed the same areas of land which their grandparents had used for generations. This is how land inheritance was mapped. However, other clan members potentially had rights to use that land as well. This system of land use has begun to change, as cash sales of vegetables have become more important. Permanency of 'ownership' has increased and boundary markers serve to remind fellow clan relatives that the land is not available to them. In the past, labour was traditionally available from the extended family to help with subsistence gardening, (i.e. for tasks like clearing forest or ploughing). This practice incurred a reciprocal obligation. These days, people want to be paid in cash'.

In summary, the results of extension activities in the EHP indicate that (as at Ramu) tree planting is likely to be undertaken by families, not communities. However, the increased privatisation of land in the EHP provides an opportunity for farmers to signify land ownership via woodlots or boundary markers. In contrast to farmers at Ramu, access to seed is a major impediment.

Results of training carried out at schools

Although the training at Waterise Primary School and Kainantu High School were well received, both nurseries ceased operations when teaching the teaching staff responsible for running their nurseries were shifted to other schools. Raising and out-planting seedlings is already part of high school (agriculture) curriculum, so inserting small-scale forestry into high schools is likely to (as in this case) to be welcomed. Further research is needed to ascertain how small-scale forestry via nurseries can be formally introduced into high schools.

Results of the forest values and usage study

The forest values and usage study (Appendix 7) provided information concerning villagers' dependency on their gardens and adjacent forest. The study was carried out in one community (Sogeram) in the forested hinterland around Madang and in two communities (Sangkian and Bopirumpun) in the grasslands of the RMV. The study involved workshops with separate women's and men's groups in the three communities. At each workshop, a series of exercises was carried out to identify forest products and services which are used and valued by the separate groups. The study found that the overall average of people's cash income (estimated as a proportion of their livelihood activities) was similar for men and women, being 42% and 39%, respectively. Project researchers suggested that the reason for women's cash income being similar to men, was that women from Sangkian and Bopirumpun sell vegetables in the market at Ramu. Nevertheless, these estimates indicate that villagers are tied both to subsistence agriculture and the cash economy. The overall proportion of villagers' cash income gained from participation in formal employment was only 21% and indicates a very high rate of un- or under-employment. This evidence is

consistent with information from a local employer that that many villagers who find employment often leave after a short period to work on their gardens.

The study also revealed much about the number and type of products collected in forests. Although housing materials were limited to house poles and matting for floors, these materials were almost universally collected and considered important. Food products dominated the lists of products sourced from forest. In particular, approximately 40% of villagers collected *Moringa oleifera* (moringa) tree seeds, *Pometia pinnata* (locally known as taun) fruit, *Pangium edule* seeds and *Canarium ovatum* (locally known as galip) nuts. Hence, tree species which provide fruit and nuts may provide one avenue of increasing tree planting.

Evaluation of previous 'train the trainer' activities
Interviews with participants of training which had been delivered by ACIAR Project "FST/2011/058 '*Facilitating Charcoal Producer Groups in PNG*' in 2012, focused on the original objectives of the training, i.e. to:

- Train participants about concepts and methods of community development to engage with community groups;
- Use the knowledge and skills gained to develop a Charcoal Business Plan for the respective groups; and
- Use the opportunity to further discuss and reach common agreements (between themselves) for micro-business management.

The trainees comprised fuelwood sellers and charcoal producers, charcoal stove producers and charcoal users.

Training included tree seedling production, woodlot establishment and micro-business management. Most participants found the training to be interesting and stated that it had helped them. Recruitment was through a local radio station. Most of the 20 initial participants were interested in the micro-business aspect but approximately 50% left when training turned to charcoal production.

After the training, participants formed a cooperative called the Wantok group with an Investment Promotion Authority certificate which allowed them to conduct a small business. With the certificate, the group opened a bank account and used the certificate and a reference from the training to seek a trading spot within the Lae main market. Unfortunately, a permanent spot could not be secured.

After the project ended, charcoal production and marketing ceased because:

- There was no centralized market venue to sell charcoal;
- Transportation was expensive for charcoal producers who lived outside Lae; and
- A lack of communication between members of the Charcoal Wantok Group caused the group to collapse.

In summary, the 'train-the-trainer' activities were successful but did not, indeed could not, encompass all the financial, marketing and institutional requirements for a successful micro-business.

Activity 2.7 Design and test improved community forestry systems

Designing and testing community forestry systems was limited to woodlots of *E. pellita,* principally at *Waritzian, Musuam Ragiumpun.* Combining trees (as an overstorey) with cacao was successful at Sangkian, (see Activity 2.6). Extension assistance at Goroka also applied a focus on tree planting rather than as a test of an improved community forestry system.

Activity 2.8 Monitoring and evaluation

M&E has occurred throughout the timeframe of activities carried out in support of Objective 2. For extension assistance, M&E is reported in the results, discussion and conclusions which are presented in Appendices 1, 11 and 20.

Except for Sangkian, the nurseries in the RMV and Kainantu have either:

- Not been monitored, partly because tree planting has ceased due to a land dispute (Waritzian);
- Continued operating as a personal hobby and source of retirement income (Barola);
- Been appropriated by a family group (Musuam); or
- Been taken over by one clan but neglected (Ragiumpun).

The success of intercropped trees at Sangkian is still being assessed. The measurement of the species trials at Goroka and Ramu in mid-2017 has also provided a snapshot of their success. This data is captured in the Microsoft database which is kept by RAIL staff.

7.3 Objective 3. Analyse policy and institutional systems that can support enhanced implementation of community forestry in PNG

Activity 3.1 Assessment of policy impacts on decision-making by landowners

A report was prepared (Appendix 17) which assessed the impacts of policy on the decisions made by landowners involved in both ecoforestry and community-based reforestation of grasslands. The assessment was based on what was learned from action research which took place as efforts to promote and explore implementation of these activities. The major impacts identified were:

- The existing policies and regulations applying to ecoforestry impose considerable financial and transaction costs on landowners wishing to engage in harvesting for commercial purposes. These costs occur because, in the absence of an explicit ecoforestry policy and supporting legislation, the relevant laws and regulations are the general laws and regulations applying to commercial forestry which are designed to regulate large-scale logging.
- In the case of community-based reforestation, there is no explicit relevant policy.[7] This has implications in the uncertainty about the future of trees planted on clan land in questions about possibilities that planted forests could become subject to control by the PNGFA and also about uncertainty about the ownership of trees when seedlings are provided by external agencies or actors (such as private companies or projects). This uncertainty affects decision-making about involvement in tree planting.
- The absence of a forestry extension system or extension policy contributes to reluctance to make decisions because of a lack of knowledge about technical options and also about relevant policies and regulations.

The review of legislation and policies relevant to ecoforestry and community forestry (see Appendix 16) clearly indicated that the policy framework applying to ecoforestry is extremely restrictive for landowners interested in engaging in it. This is best understood in the context

[7] The implications of the new program “Painum Graun, Plantim Diwai” (Find land, plant trees) need to be assessed. However, the program is not about community-initiated reforestation but about the PNGFA obtaining land from landowners for reforestation.

that there is an effective policy vacuum regarding ecoforestry. A draft White Paper was prepared leading up to 2004. It is still in draft form and unchanged since then. The policies in that draft paper were essentially concerned with regulating rather than enabling ecoforestry.

Activity 3.2 Policy workshop to review ecoforestry/community forestry policy

The policy workshop which was intended to be undertaken with key stakeholders to review ecoforestry/community forestry policy with PNGFA did not proceed for two reasons: Firstly, there was no evident interest in a policy workshop from landowners. Secondly, there had been considerable discussion of policy issues at other venues involving the PNGFA and other stakeholders. In particular, the ACIAR PNG Forestry Policy Workshop held in Port Moresby in May 2015 provided an opportunity to canvas policy issues.

Activity 3.3 Recommendations for institutional arrangements to support community forestry

Recommendations for institutional arrangements to support community forestry were prepared as a policy options report for consideration by the PNGFA (Appendix 18). The decision to present “policy options” rather than “policy recommendations” was made because there had been some expressions of reluctance from PNGFA officials about the too much interference in policy issues. The policy options identified were:

1. The need for the draft policy for ecoforestry to be revised and implemented is a high priority. It is suggested that the revised policy should be focused on removing some of the regulatory barriers associated with large scale harvesting operations in order to allow small-holder ecoforestry operations to function. This would involve removing some of the costs and complexity of obtaining TAs, either by revising the regulations as they relate to ecoforestry or providing a separate form of authority for timber harvesting by smallholders.

2. While the legislation under which ILGs are formed is not a responsibility of the PNGFA, the PNGFA should consider modifying requirements for participation in a TA to allow groups that are not registered as ILGs to participate. This might involve advocating amendments to the Land Group Incorporation Act.

3. While issues of financing for equipment are matters of banking policy, not of forest policy, they nevertheless impact on the capacity of smallholders to engage in ecoforestry. It is obvious that the PNGFA cannot directly address this issue, but we suggest that it would be useful to engage in discussion with banks (especially the NDB) to consider ways to facilitate funding.

4. It is suggested that the PNGFA support further research on revised Reduced Impact Logging guidelines suitable for small scale forestry.

5. There is a need for policy that clarifies ownership of planted trees on clan land. The policy would need to specify that trees planted on clan or individual clan members’ land would belong to the landowner regardless of the source of seedlings. The exception, spelt out in policy, would be where a clear Memorandum of Understanding between the landowner(s) and an individual or group/agency supporting planting specifies a different arrangement.

6. A clear policy on whether the government can impose a Forest Management Agreement, Forest Clearing Authority or TA on plantations planted by a community would address a disincentive for communities to establish plantations on clan land.

7. Development of a clear policy on forestry extension is needed to assist in the promotion of forestry activities.

8. Access to policy documents, including regulations and summaries of relevant policy for landowner use needs to be promoted by distribution of these documents to all provincial PNGFA offices and by updating and maintaining the PNGFA website.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The scientific impact of our observations of extension-based activities in PNG will be a re-direction of native forest harvesting and reforestation activities away from purely biophysical aspects (e.g. portable sawmills, nurseries and species trials) towards an integrated and sequential approach to native forest management and reforestation in which social preparation and negotiation precede material inputs.

The impact of project work to the wider scientific and policymaking community has initially been to publish project results in scientific journals and to present project results at international conferences. This process is already underway in journal papers being prepared for publication. These papers will be based on material presented in Appendices 4, 5 and 6.

For both Objectives 1, and 3, our research findings provide a clear picture of a way forward for timber resource owning communities. A summary of our research is that:

1. Timber royalty payments to landowning communities are unrealistically low compared to the commercial value of sawlogs harvested from native forest;
2. Community operated portable sawmills are invariably unprofitable, if operated by communities and in compliance with existing legislation;
3. Sawmill or timber processor owner-operated portable sawmills are both widespread and profitable but operate without legal permits and authorities;
4. These portable sawmills pay resource owners a higher royalty that government-set royalties for native forest harvesting.

These findings illustrate that a new approach to native forest harvesting in PNG is possible. This approach may involve legalising logging practices which are already occurring as illegal or quasi-legal operations. Policy change will be required which allows communities to directly engage with portable sawmill operators and to negotiate their own royalty prices. Publishing Appendix 4 in the academic journal *Land Use Policy*, and publishing appendices 5 and 6 in similar high-quality journals will present this research to a wider audience.

For Objective 2, the model of factors influencing the success of community forestry groups (Baynes et al. 2015) has been published in a leading international journal. This paper is already being well cited within the scientific literature related to community forestry. A paper '*The complex pathway to collective action in a clan-based society*' (Appendix 1) was presented to the FLARE Conference in December 2016 in Edinburgh. A revised version of the paper has been published in the Journal of Rural Studies. A paper '*Accommodating group heterogeneity in forest landscape restoration*' has been submitted for a special edition of the journal 'Environmental Conservation'. A further paper titled '*Applying Ethics to Forest and Landscape Restoration*' was presented at the FLARE Conference in October 2017 in Stockholm.

The long-term scientific impact will be the renewed focus on tree and cash crop combinations. Including trees in multi-species, multi-purpose, livelihood-based farming is not new, but as a model of reforestation it is new to Melanesia. Hence, the case study at Sangkian will act as a precursor to rolling out this farming system in other communities across the landscape. We emphasise that scaling-up may occur across a *social* rather than a *geographic* landscape.

The longer-term scientific impact of the species trials will be significant. The species trials in the RMV will contribute, through the PhD research of Will Unsworth, to an understanding of the most socially and ecologically appropriate species for reforesting the extensive grasslands in the RMV. The field trial in Goroka will serve as a field learning laboratory for

the PNGFA and other stakeholders, to provide crucial information on appropriate planting design and silvicultural techniques.

8.2 Capacity impacts – now and in 5 years

Capacity building occurred through attendance and presentation of papers by the following key project partner staff at the 2015 IUFRO 3.08 Small-scale Forestry Conference, hosted by the University of the Sunshine Coast (USC) on the Sunshine Coast in Queensland, Australia:

- Dr Martin Golman, Mr Bonti Krasi and Ms June Mandawali (FRI)
- Mr Warea Andasua and Ms Vincianna Andrew (FA Goroka);
- Mr Mark Winai (FPCD).

Mr William Unsworth has enrolled as a PhD candidate at USC with Professor John Herbohn as his principal supervisor. His work will focus on the original vegetation of the RMV and provide direction for the most appropriate combinations of biodiversity conservation and reforestation. Sponsoring Ms Vincianna Andrew (FA Goroka) for an Honours program of study, together with support from the PNGFA has increased her capacity to undertake scientific research. Engaging Ms Melinda Thom (Community Engagement Supervisor at RAIL) has also provided her with opportunities for professional development.

The project has also developed the capacity of local partners. Key impacts have been:

- A formal social science training workshop attended by 16 research collaborators and four Australian-based researchers; and
- Continuous and intensive mentoring of project staff engaged in fieldwork, including developing both social science research capacity and technical skills.

The social science training workshop provided training in relevant social science methods and some social science concepts which enabled participants to effectively engage in fieldwork. While a short workshop in itself could only enable increased awareness of these aspects of social science, combined with ongoing mentoring, there was an obvious increase in the capacity of field partners to engage in the field research. Evidence of improved skills and commitment is clear from the contribution of PNG-based partners to reports and presentations on field studies including those presented at the IUFRO conference in 2015 (Section 8.4).

In addition, Australian researchers have provided extensive advice and training to FRI and RAIL staff on nursery propagation, reforestation techniques and the design of species trials. This training has improved the capacity of these organisations to undertake successful reforestation activities. In the case of RAIL, changes to nursery practices resulted in substantial improvement in the quality of seedlings produced for both restoration and field trials. The project has also built capacity of PNGFA staff to design and implement field trials. Team members worked with local collaborators at RAIL, FRI and the PNGFA to design and implement a series of field trials to provide information on reforestation techniques, especially in the use of native species. It is expected that the benefits of this capacity development will flow through to surrounding communities, especially in relation to nursery establishment and seedling propagation procedures.

8.3 Community impacts – now and in 5 years

The project commenced in September 2013, but implementation of field reforestation trials and extension activities were interrupted by the El Niño drought of 2015 which effectively precluded seedling production and tree planting for over a year. Following the onset of the rains, the project was able to transfer nursery and tree planting technology to four main communities in the RMV, one community at Kainantu and thirty individual farmers at

Goroka. The most successful of these activities have been at Waritzian (woodlot establishment) and Sangkian (livelihood-based planting).

8.3.1 Economic impacts

An underlying purpose of the project was to explore options to provide economic benefits to rural communities through tree planting or managing native forest. For ecoforestry, the research showed that the current policy and legislative environment poses limitations for achieving economic impacts through improved native forest management. Although this is a negative result, project results provided clarification concerning portable sawmills and CMUs. Both of these approaches to harvesting and marketing native forest timbers have proved unviable in the current context of PNG law and regulations. However, the economic impact of the project will be highly positive if the PNG government makes institutional change which supports (and legalises) changes which allow resource-owning communities to negotiate royalty payments in the market place. In the case of reforestation, the species trials will identify appropriate species for final field testing.

8.3.2 Social impacts

The main social impact arising from project activities will be through its contribution to extension theory which is applicable to PNG and Melanesia. Project research results have suggested that community forestry is not an appropriate approach to reforesting the PNG grasslands. On land which is tightly owned and managed by clans, project research results have shown that family or small group extension is more likely to succeed compared to larger groups. This finding specifically applies to the RMV and the EHP.

Monitoring of livelihood-based reforestation at Sangkian is expected to provide further guidance for how people's livelihoods may be improved through short-term cash crops as well as longer-term timber crops.

8.3.3 Environmental impacts

The environmental impacts of project activities are at an early stage. However, tree growing at Waritzian, Musuam, Barola and Sangkian are all reducing community reliance on native forest for firewood and house poles. These native forest products are being replaced by fast growing *E. pellita* poles. In addition, introducing *Canarium ovatum* and *Pometia pinnata* to the RMV will reduce people's reliance on other staple foods.

8.4 Communication and dissemination activities

Pacific Island Projects (PIP), through its Managing Director Simon Rollinson, has posted details of the project on the PIP website. This information can be accessed at the following link –

http://www.pip.com.pg/projects/completed-projects/104-comumunity-forestry-project.html

PIP have been a supportive partner in communicating and disseminating project outputs (i.e. findings, outcomes, collection of downloadable resources including field notes and reports, research papers and extension materials).

Project staff have achieved an excellent working relationship with staff from project partners and are now welcomed in the villages of Musuam, Waritzian, Dumpu, Sankiang, Marawasa, Wankung and Ragiumpun. Further research activities will be possible in these villages.

At Goroka, links to local villages have been successful because of the assistance of local PNGFA staff. Two cohorts of villagers (31 people in all) have been trained in nursery technology. The FA Goroka Technical Superintendent, Mr Warea Andasua, has written a nursery training manual which relates to Objective 2.6. For other extension activities, the Tree Growers Tool Kit which was developed during FST/2004/050 '*Value Adding to PNG's Agroforestry Systems*' proved to be valuable.

Regular meetings with project partners obviated the necessity for annual planning and review workshops but Dr Martin Golman, Mr Bonti Krasi and Ms June Mandawali (FRI), Mr Warea Andasua and Ms Vincianna Andrew, (FA Goroka) and Mr Mark Winai, (FPCD) attended the IUFRO 3.08 Small-scale Forestry Conference held on the Sunshine Coast in Queensland, Australia, in 2015 to present papers, including:

1. Andrew, V., Andasua, W., Baynes, J. (2015) Why Can't a Country with So Many Trees Grow Enough Firewood?
2. Smorfitt, D., Baynes, J., Fisher, R., Harrison, S., Herbohn, H., Winai M. (2015) Making Informed Financial Decisions in Community-owned Native Forests.
3. Winai, M., Fisher, R., Naus, D. (2015) Living custom: The relevance of customary beliefs in forest management in Madang Province, PNG.

The following paper was presented at a national conference at the University of Papua New Guinea in 2014:

1. Fisher, R., Miskaram, N., Faitelli, A., Herbohn, J., Baynes, J., Smorfitt, D., and Holzknecht, H. (2014) Challenges to upscaling community ecoforestry and community-based reforestation in Papua New Guinea Paper presented at conference Promoting Responsible Sustainable Development Through Science and Technology, The PNG Way, University of Papua New Guinea. (Published in conference proceedings 2016.

The following two papers have been presented at the annual meeting of the Forests & Livelihoods: Assessment, Research, and Engagement (FLARE) organisation.

1. Baynes, J., Herbohn, J., Fisher R., and Unsworth W. (2016) The complex pathway to collective action in a clan-based society. Paper presented to the annual Forests & Livelihoods: Assessment, Research, and Engagement (FLARE) conference Edinburgh, December 2016[8].
2. Baynes, J., Herbohn, J., Gregorio, N. and Unsworth W. (2017) Applying Ethics to Forest Landscape Restoration. Paper presented to the annual Forests & Livelihoods: Assessment, Research, and Engagement (FLARE) conference Stockholm, September, 2017.

A further paper, i.e. Baynes, J., Herbohn, J., Gregorio, N. and Unsworth W. (2017) '*Applying group and collective action theory to community forestry in a social landscape*' has been accepted (pursuant to revision) by the academic journal 'Environmental Conservation' for publishing in a special edition in 2018.

Three project reports have been forwarded to the PNGFA for comment and review. These reports are:

1. Appendix 16. 'Review of Legislation and Policies Relevant to Community Forestry in Papua New Guinea'
2. Appendix 17. 'Report on the impact of policy on small-holder decision-making and community forestry activity in Papua New Guinea'
3. Appendix 18. 'Report on policy options for the support of ecoforestry and community-based reforestation in Papua New Guinea'.

[8] *A revised version of the paper has been published in the Journal of Rural Studies as Baynes et al. (2017) 'Reforesting the grasslands of Papua New Guinea: The importance of a family-based approach'.*

9 Conclusions and recommendations

9.1 Conclusions

The key learnings in terms of each of the project objectives are:

Enhance the scaling-up of community ecoforestry in native forests

A key finding from the research on scaling-up ecoforestry is that there are major barriers to ecoforestry. These barriers include:

- Buyer's requirements for lumber quality, quantity and regularity of supply;
- Achieving economies of scale to reduce processing costs;
- Clan's traditional antipathy to multi-clan cooperation (to address economies of scale); and
- Transaction and financial costs involved in meeting regulatory requirements for harvesting forests for commercial purposes.

These barriers may be obviated if communities are permitted to engage and negotiate with timber purchasers. The operations of these purchasers may technically be illegal, but because they use trained operators and because they can readily shift from site to site, they avoid the lumber quality and quantity problems which have contributed to the collapse of NGO-supported, community-managed portable sawmill operations in the past. Legislative and practical government support will be necessary.

A further set of findings relates to the social dynamics involved in forestry activities. The most important point is that economic activities, such as forestry business activities, tend to be the concern of individuals or small groups rather than clans as a whole, while ownership of land and forests is at clan level. This finding also relates to reforestation of grasslands under Objective 2.

Develop appropriate systems for the scaling-up of community-based reforestation of grasslands

The key conclusion from research into the scaling-up of community-based reforestation in the grasslands is that biophysical aspects of tree growing are subordinate to the challenges of achieving intra- and inter-clan cooperation which will allow security of access to long-term crops and protect trees from fire. Multi-species, multi-use, livelihood-based tree and cash crop combinations offer the best hope for adoption and diffusion to other communities.

Clan-based governance has not traditionally been focused on economic activities which occur on land allocated to specific families. As with mining and other development, interest in these activities from other clan members increases with their permanence and cash generating ability. Hence, successfully introducing livelihoods-based reforestation will necessarily require extensive consultation and negotiation.

Successfully reforesting the grasslands will also depend on livelihood generation (cash) as well as small-scale tree planting. Success will be predicated on extended clan-wide negotiations to ensure security of tenure and fire protection for family-based plantings. Addressing biophysical issues (e.g. access to high-quality germplasm) will also be necessary on a case-by-case basis, particularly in the EHP.

Analyse policy and institutional systems that can support enhanced implementation of community forestry in PNG

From a policy and regulatory perspective, the key challenge to the adoption of ecoforestry is to provide communities with a process which enables them to comply with government legislation and other regulations, so that they can negotiate freely in the marketplace. A PNGFA extension and advisory branch would assist communities with this process. The problem is that at present there is no specific policy relevant to ecoforestry. This means that

ecoforestry is, by default, subject to the broad provisions of forestry law and policy, many elements of which are intended to apply to large-scale forest operations.

This project found that forest-owning communities had little idea of what their trees were worth or how to sustainably manage them. Government agencies cannot settle clan disputes, but they can assist communities with land management planning. For landowning communities, there is a clear and present need for assistance with mapping, forest classification, boundary demarcations and resource inventory.

Institutional arrangements which support ecoforestry should be mirrored with assistance to communities who live in the grasslands. Assistance with biophysical issues such as a lack of seed, seedling quality and availability of high-quality cacao and coffee seedlings would provide the motivation for many farmers to engage in agroforestry.

9.2 Recommendations

There are two key final recommendations:

1. Further research should be carried out to identify and address regulatory barriers which limit the access to timber markets by small-scale producers who wish to engage in ecoforestry. This would identify methods of removing some of the costs and complexity of obtaining TAs, either by revising the regulations as they relate to ecoforestry or by providing a separate form of authority for timber harvesting by smallholders. While the legislation under which ILGs are formed is not a responsibility of the PNGFA, the research could identify how the PNGFA could modify requirements for participation in a TA to allow groups that are not registered as ILGs to participate. This might involve advocating amendments to the Land Group Incorporation Act.

2. For reforesting the grasslands, it is recommended that further research be undertaken to replicate a scaled-up version of the initial livelihood-based reforestation case study which was undertaken by this project at Sangkian. This research should seek to identify the reforestation methods and procedures that are most likely to ensure success in other community contexts. The findings should form the basis of subsequent scaled-up reforestation at other communities in the RMV and the EHP. A caveat to further extension activities is that reforestation may be more successful with families or family-groups rather than clans. Research to achieve this objective is the major recommendation of this project.

10 References

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Baynes, J. Herbohn, J. Fisher, R. Unsworth, W. (2016) The complex pathway to collective action in a clan-based society. Paper presented to 'Forests & Livelihoods: Assessment, Research, and Engagement' Conference, 2-5 December 2016, Edinburgh, UK.

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10.2 List of publications produced by the project

Journal Article

Baynes, J., Herbohn, J., Smith, C., Fisher, R., Bray, D. (2015) Key Factors which Influence the Success of Community Forestry in Developing Countries. *Global Environmental Change*. 35: 226-238

Baynes, J. Herbohn, J. R. Unsworth, W. (2017) Reforesting the grasslands of Papua New Guinea: The importance of a family-based approach. *Journal of Rural Studies*. 56:124-131.

Baynes, J., Herbohn, J., Gregorio, N. and Unsworth W. (2017) 'Managing group heterogeneity in forest landscape restoration' (accepted, following revision in the journal *Environmental Conservation* for a special edition in 2018).

Conference Proceedings

Fisher, Robert, Norlie Miskaram, Alfred Faitelli, John Herbohn, Jack Baynes, David Smorfitt and Hartmut Holzknecht (2016) “Challenges to upscaling community ecoforestry and community-based reforestation in Papua New Guinea”. In Victor Temple, David Mowbray, Prem P. Rai, Osia Gideon, Chalapan Kaluwin and John Watmelik (eds) *Promoting Responsible Sustainable Development Through Science and Technology, The PNG Way*, Proceedings of Research Science & Technology Conference 2014, University of Papua New Guinea. Vol 2, pp 32-39.

Conference Presentations

Andrew, V., Andasua, W., Baynes, J. (2015) *Why Can’t a Country with So Many Trees Grow Enough Firewood: Challenges Facing Forest Extension Officers in Goroka, Papua New Guinea*. Paper presented to IUFRO Research Group 3.08 Small-scale Forestry Conference. Small-scale and Community Forestry and the Changing Nature of Forest Landscapes. Sunshine Coast, Australia, 11-15 October 2015 (Appendix 11).

Baynes, J., Herbohn, J., Fisher R., and Unsworth W. (2016) *The complex pathway to collective action in a clan-based society*. Paper presented to the annual Forests & Livelihoods: Assessment, Research, and Engagement (FLARE) conference Edinburgh, December 2016 (Appendix 1).

Baynes, J., Herbohn, J., Gregorio, N. and Unsworth W. (2017) *Applying Ethics to Forest Landscape Restoration*. Paper presented to the annual Forests & Livelihoods: Assessment, Research, and Engagement (FLARE) conference Stockholm, September, 2017 (Appendix 20).

Scudder, M. (2015) *Review of Institutional Frameworks to Support Eco-forestry: What Might Work in Papua New Guinea*. Paper presented to IUFRO Research Group 3.08 Small-scale Forestry Conference. Small-scale and Community Forestry and the Changing Nature of Forest Landscapes. Sunshine Coast, Australia, 11-15 October 2015.

Smorfitt, D., Baynes, J., Fisher, R., Harrison, S., Herbohn, H., Winai M. (2015) *Making Informed Financial Decisions in Community-owned Native Forests*. Paper presented to IUFRO Research Group 3.08 Small-scale Forestry Conference. Small-scale and Community Forestry and the Changing Nature of Forest Landscapes. Sunshine Coast, Australia, 11-15 October 2015 (Appendix 3).

Winai, M., Fisher, R., Naus, D. (2015) *Living custom: The relevance of customary beliefs in forest management in Madang Province, PNG*. Paper presented to IUFRO Research Group 3.08 Small-scale Forestry Conference. Small-scale and Community Forestry and the Changing Nature of Forest Landscapes. Sunshine Coast, Australia, 11-15 October 2015.

11 Appendices

NOTE: Due to the large file size of several appendices they are included as separate documents.

Appendix 1: Baynes, J., Herbohn, J., Unsworth, W. (2016) The complex pathway to collective action in a clan-based society.

Appendix 2: Baynes, J., Herbohn, J., Smith, C., Fisher, R., Bray, D. (2015) Key factors which influence the success of community forestry in developing countries.

Appendix 3: Smorfitt, D., Baynes, J., Fisher, R., Harrison, S., Herbohn, J., Winai, M. (2015) Making informed financial decisions in community-owned native forests.

Appendix 4: Scudder, M. (2017) A feasibility study on implementing an eco-forestry central marketing unit in the Madang Province of Papua New Guinea.

Appendix 5: Scudder, M. (2018) Timber royalty reform to improve the livelihoods of forest resources in Papua New Guinea.

Appendix 6: Scudder, M. (2018) Are portable sawmills a financially viable option for forest management in Papua New Guinea?

Appendix 7: Fisher, R., Smorfitt, D., Baynes, J., Winai, M., Unsworth, W., Thom, M. (2016) Report on forest values and usage study.

Appendix 8: Fisher, R., Miskaram, N., Faitelli, A., Herbohn, J., Baynes, J., Smorfitt, D., Holzknecht, H. (2016) Challenges to up-scaling community ecoforestry and community-based reforestation in Papua New Guinea.

Appendix 9: Gregorio, N. Andasua, W. (2016) Establishing the planting layout of mixed-species and variable spacing trials.

Appendix 10: Gregorio, N. (2016) Extract from report titled 'Establishing the Field Trial at Goroka'.

Appendix 11: Andrew, V., Andasua, W., Baynes, J. (2015) Forest extension in the Eastern Highlands of Papua New Guinea.

Appendix 12: Baynes, J., Herbohn, J., Gregorio, N., Unsworth, W. (2018) Accommodating group heterogeneity in forest landscape restoration.

Appendix 13: Andasua, W. (2016) Report on the 2nd Community forestry nursery training.

Appendix 14: Andasua, W. (2015) Neseri trening buk.

Appendix 15: Mandawali, J. (2017) Charcoal producer's training evaluation report.

Appendix 16: Holzknecht, H. (2017) Review of legislation and policies relevant to community forestry in Papua New Guinea.

Appendix 17: Fisher, R. et al. (2017) Report on the impact of policy on smallholder decision-making and community forestry activity in Papua New Guinea.

Appendix 18: Fisher, R. (2017) Report on policy options for the support of ecoforestry and community-based reforestation in Papua New Guinea.

Appendix 19: Fisher, R. (2017) Report on social dynamics and collective action in community forestry in Papua New Guinea.

Appendix 20: Baynes, J., Herbohn, J., Gregorio, N., Unsworth, W. (2017) Applying Ethics to Forest Landscape Restoration.